Optimization of elastomer layer in CLT panels for vibration reduction

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Reducing vibration and sound in buildings is important for creating a healthy and comfortable living environment for residents. Vibrations from footsteps, music and other activities can travel through floor structures and lead to unwanted noise and disturbances inside a building. Controlling these effects is, therefore, an important aspect of building design. This thesis investigates how an elastomer layer within cross-laminated timber floors can be designed to reduce vibrations across a range of frequencies using numerical methods.

As the demands on reducing climate impact of buildings raise, the interest of using wood as a construction material increases, as this is often considered an environmental friendly material. A problem with wooden structures, can be the vibrational and acoustic performance, which can make them to be perceived as noisy. In the process of reducing noise and vibrations, using elastomer (which is a rubber like material), in the floor structure can be useful. In this thesis, it has been investigated how such a material can be used to efficient reduce vibrations.

The vibrational response is evaluated by loading the structure with a harmonically varying force. The acceleration is analyzed when the response of the panel varies harmonically with the applied force. A scalar value, representing the acceleration can be evaluated. By changing the forcing frequency a new value is obtained. This is done over a range of frequencies, so that a *frequency response function* (FRF) can be established. An example of how an FRF can appear is presented in Figure 1

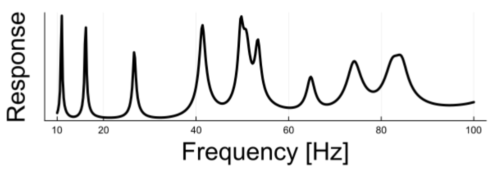

Figure 1: *Example FRF, displaying the response over a frequency range*

The floor structure considered is timber panels, constructed from wooden laminates, which has been glued together in layers, where each layer is orthogonal to the layer above and underneath. These panels are called *cross laminated timber* (CLT) panels. In this work, a layer of an elastomer is included among the wooden layers. In Figure 2 an example cross-section of a CLT panel with elastomer layer is shown.

Figure 2: *Example cross-section of a CLT panel with an elastomer layer*

The configuration of the rubber-like layer is investigated, where material are removed so that voids are created. As the intention is to minimize the response, an FRF, are used as base for the objective function, both by minimizing the integrated value over the frequency range, and by minimizing the peak values.

The model used, indicate, that reduction of vibrational response, considering root mean square (RMS) values over the frequency range, in the span of 10-20%, and a reduction of the peak value by 25-30%, is possible. Achieved by modifying the configuration of the targeted layer. The layer appearing shows an interesting pattern, where an example is shown in Figure 3.

Figure 3: *Example of how an optimized configuration of the elastomer layer can appear, seen from above. Black areas are elastomer and white are void.*

This thesis may contribute to knowledge of how timber panels can be designed, and the method used could serve as a compliment to trial and error approaches by providing a path to follow when seeking the optimal solution.

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